



Internet of Things: An Experiment with Residential Automation for Robotics Classes



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Article history:

Received: 27 August 2017

Revised: 28 January 2018

Approved: 6 February 2018

Published: 10 February 2018

Keywords:

IoT;

Robotic;

Internet;

Arduino;

Automation;

Abstract

This study presents the results obtained in a technological and applied research for robotics disciplines, using the Internet of Things with the device Arduino Uno to automate the lights of a residence, to have the ease of control during the day to day, the panel of control is accessed by a browser software on a mobile phone or computer, providing greater convenience for people. During the research were analyzed the different devices available in the national market, the results allowed to conclude the development of a simple solution that could contribute to robotics classes, the main interest related to the results involves the application experience, which can be expanded according to with the need of the user and its environment, proposing new applications in disciplines that involve robotics, database, internet, programming and electronics.

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1. Introduction

The development of this project was based on personal and professional interest, while following the development of solutions for the disciplines that involve the Internet of Things for residential automation, in order to facilitate the way of accessing electronic devices in homes, since each the population is adjusting to new technologies that bring more facilities and amenities into their lives.

The main goal of the project is to upgrade lamps automatically using a cell phone or computer, but other functions connected to an Arduino board and connected to the Ethernet Shield card must be implemented and connected to other devices, if there is one an internet connection. To access the control, a smartphone or computer with the user's preferred operating system should be used, remembering that in order to operate, the user must have a browser installed on his device and there must also be some established connection with the internet, so that communication between the application and the board is possible.

As it presents Rodrigues [12], when speaking of automation in general, it is normal to think of the Arduino boards or some platform model like the Raspberry Pi. Both brands have a popularity for ease of use in developing

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technologies for communication between devices as well as for their low cost in the domestic market. The Arduino boards were created in Italy with an educational objective to students, its most popular model is the Arduino UNO, there are some features called Shields which is a kind of extension and serves to add specific features the same as the Arduino UNO board does not have ability to connect to the internet with an Ethernet Shield this would be possible.

The Raspberry Pi platforms Bhadoria [3] are newer, started to be launched from 2012, had an initial intention to assist in the educational field with low cost, are basically small computers generally based on the Linux operating system, Arduino does not have a lot of Shield available. The Raspberry Pi board involves a complex procedure due to the need to install and configure the Raspberry Pi operating system, but they can also work in applications that involve hardware logic, so the best choice will depend on the needs of the user.

Residential automation has great potential and challenges to become more popular, such as the cost of materials, which are already becoming more affordable and may be cheaper yet. Automated systems can bring us many benefits for comfort, safety, affordability and even have sustainability projects in homes. You can have a control center from your cell phone, with greater security when you go out to work, or travel for days, and even weeks without worry, because there are remote monitoring systems of the cameras, or the case of leakage of gas or water, the owner is notified immediately by notifications.

In addition to safety and comfort, the economy is another important factor, and residential automation systems help reduce water and energy consumption, with actions programmed to save money. With so many benefits the home automation is one thing that will have a stronger home trend in society. In analyzing Deval's [5] work, people want to grow and live in our homes until the last days of life and, by avoiding dependency on children, grandchildren or going into an asylum by dependence on them, investing in residential automation is investing in their good and future security, in other words, is to maintain their independence as an elder.

A person in the third age usually starts having difficulty getting around and also a small memory problem. Residential automation contributes to the physical security of the elderly, reducing the risk of accidents, avoiding unnecessary locomotion and minimizing the effects of health problems, for not remembering to take the medicine, for example. The studies were developed on the materials presented by: Almeida [1]; Banzi & Shiloh [2]; Bhadoria & Ramos [3]; Br-arduino.org [4]; McRoberts [7]; Monk [8]; Porter [10]; Rodrigues [12]; Spivey [13]; Thomsen [14], which deals both in the development of solutions for the internet of things, and in the construction of devices to meet different residential automation projects.

2. Research Methods

The following tools were used to achieve the objectives set and established by the project: Scientific research in articles, dissertations, theses, magazines and technical documents, videos and websites of manufacturers, for a better understanding of the application of available technology. Technical and applied research was used. At first, an analysis was made in the literature, in articles searches that approached subjects such as: Residential Automation, Arduino, difference between Arduino and Raspberry Pi.

With the materials chosen to carry out the project, some components (Arduino Uno, Arduino WiFi Shield, long pin connector and relay) were acquired and the source code will be available, in which later communication between the user and the environment through the internet. How explain Marconi & Lakatos [6] the use of experimental research and applied research, involves the use of different technologies for validate the results, in this way, the devices are presented in your structure, and applied development of solutions to attend the Project, is importante to thing that exists various kind of Project, with different size and application.

3. Results and Analysis

To attending the Project, was selected the devices as showed bellow, with them was possible validate the results and demonstrate a real situation to use the internet of things, more details are presented bellow.

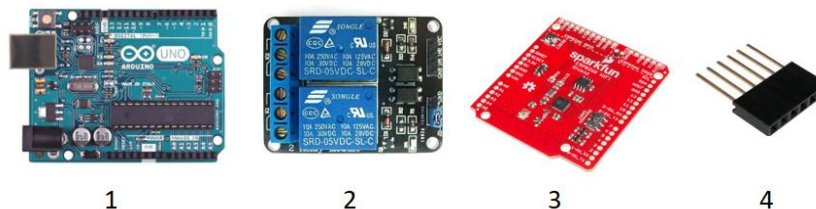


Figure 1: *Devices used during the project. Adapted by the author.*

The Arduino Uno shown in Figure 1, item 1 Multilogica [9], is an ATmega328 based micro controller board. It has 14 digital input / output pins (6 of which can be used as outputs), 6 analog inputs, a 16MHz crystal oscillator, a USB connection, a power input and a reset button. It contains the necessary components to support the micro controller, it is simply necessary to connect to a computer through the USB port, or to feed it with a source.

The design uses a relay as shown in Figure 1, item 2, which is an electromechanical device that allows the activation of electric charges from a low power control circuit, such as a digital signal. It works exactly like a switch. The Arduino WiFi shield Sparkfun ESP8266 (Learn Sparkfun), shown in Figure 1, item 3, connects and enables Arduino control over the internet and 802.11 b / g / n Wireless networks with Sparkfun ESP8266 Wifi Shield. The Arduino Connector Br-arduino.org, [4], shown in Figure 1, item 4, is a very useful product during project development, it is responsible for connecting the Wifi Shield on the Arduino board.

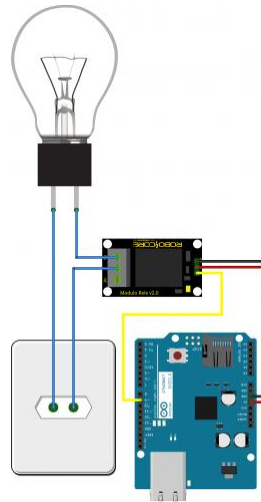


Figure 2: Controlled circuit for control a lamp. Robocore.net [11]

With all the resources properly connected, it is possible to load the code for the Arduino, by its IDE, the code presented by Robocore.net [11] for testing should be used.

```

1  #include <SPI.h>
2  #include <Ethernet.h>
3
4  byte mac[] = { 0x90, 0xA2, 0xDA, 0x0F, 0x09, 0xA7 }; //physical mac address
5  byte ip[] = { 192, 168, 0, 99 }; // ip in lan
6  byte gateway[] = { 192, 168, 0, 1 }; // internet access via router
7  byte subnet[] = { 255, 255, 255, 0 }; //subnet mask
8  EthernetServer server(80); //server port
9
10 String readString;
11
12 int pin = 9;
13 boolean ligado = true;
14
15 ///////////////////////////////////////////////////
16
17 void setup(){
18
19   pinMode(pin, OUTPUT); //pin selected to control
20   //start Ethernet
21   Ethernet.begin(mac, ip, gateway, subnet);
22   server.begin();
23   //the pin for the servo co
24   //enable serial data print
25   Serial.begin(9600);
26   Serial.println("RoboCore Remote Automation V1.1"); // so I can keep track of what is loaded
27 }
28
29 void loop(){
30   // Create a client connection
31   EthernetClient client = server.available();
32   if (client) {
33     while (client.connected()) {
34       if (client.available()) {
35         char c = client.read();
36
37         //read char by char HTTP request
38         if (readString.length() < 100) {
39
40           //store characters to string
41           readString += c;
42           //Serial.print(c);
43         }
44
45         //if HTTP request has ended
46         if (c == '\n') {
47
48           /////////////////////////////////////////////////// control arduino pin
49           Serial.println(readString); //print to serial monitor for debugging
50           if (readString.indexOf("?ligar") > 0) //checks for on
51           {
52             digitalWrite(pin, HIGH); // set pin 4 high
53             Serial.println("On");
54             ligado = false;
55           }
56           else if (readString.indexOf("?desligar") > 0) //checks for off
57           {
58             digitalWrite(pin, LOW); // set pin 4 low
59             Serial.println("Off");
60             ligado = true;
61           }
62         }
63         //clearing string for next read
64         readString="";
65
66         ///////////////////////////////////////////////////
67
68         client.println("HTTP/1.1 200 OK"); //send new page
69         client.println("Content-Type: text/html");
70         client.println();
71
72         client.println("<html>");
73         client.println("<head>");
74         client.println("<title>RoboCore - Remote Automation</title>");
75         client.println("<meta http-equiv='Content-Type' content='text/html; charset=ISO-8859-1'>");
76         client.println("<link rel='stylesheet' type='text/css'");
77         href="http://www.robocore.net/upload/projetos/RemoteAutomationV1.0.css" />");
78         client.println("<script");
79         src="http://www.robocore.net/upload/projetos/RemoteAutomationV1.0.js"></script>");
80
81         client.println("</head>");
82         client.println("<body>");
83         client.println("<div id='wrapper'>RoboCore Remote Automation V1.1");
84         client.print("<div id='rele'></div><div id='estado' style='visibility: hidden;'>");
85         client.print(ligado);
86         client.println("</div>");
87         client.println("<div id='botao'></div>");
88         client.println("</div>");
89         client.println("<script>AlteraEstadoRele()</script>");
90         client.println("</body>");
91         client.println("</html>");
92
93         delay(1);
94         //stopping client
95         client.stop();
96
97
98
99
100 }
101 }
102 }
103 }
104 }
105

```

Figure 3: Hard code to generate the HTL page for control the lamp. robocore.net [11]

Then the logic part of the project was loaded, to control the activation of the lamps, using the devices like smartphone, or computer with Internet access, and having as main base, the Arduino board, it receives the code that causes the Arduino works as a server, hosting the page that was developed so that the devices can control the lighting.



Figure 4: Control page. By the author.

In the browser software of the device, there will be the option to turn the project lamps on and off with just one click, but for this to be possible, the resources will have to be both connected to an internet network in order to have access and response from the system.

The project was developed to be accessed from any device that has access to the internet and with a user interface intended for the target audience in a way that is easy to handle. The objective of the project was to demonstrate a home automation system capable of bringing comfort to the individual, not having to move up to a switch and economizing at a cost affordable to the majority of the population. With the system you can perform tasks such as turning on and off the lighting of several rooms in a residence, or even turning on an air conditioning system, and can even turn on / off any device connected to the internet.

The Arduino board in conjunction with Ethernet Shield has the function of being an embedded system of the project, that is, it will be the computer responsible for the operation of the system in real time. It will also interact with the user through the display and keyboard, placing the possibility of direct actions with the equipment, and also the visualization of images recorded by cameras, if the user opts for this model. A preset presence sensor can be added to disable the lighting system when there is no movement inside the residence or room, thus helping to improve control over energy consumption.

Automation generally has challenging scenarios today, because of the high cost of installation, and the lack of easy interaction with users, things that this project minimizes with open source technologies, proposing ease of access and, with a relatively low effort to people with little programming knowledge. Residential automation has been growing in large residential and corporate environments, with the advancement and emergence of new, more affordable technologies. Nowadays, more and more people are trying to bring basic necessities such as comfort, accessibility, security, economy and practicality into their homes.

Projects of this kind are receiving greater publicity in society, because this model allows the appearance of a variety of other projects, more complete and with more accessibility for the poorest population, providing the appearance of more projects for our planet and humanity. There is an infinity of application of these resources in different types of projects, being this result a small demonstration of an application in systems, which can provide an interest of the student in relation to the use of computational, electronic resources among others for the control of remote devices , as well as distance solutions.

4. Conclusion

The objective of a practical application of a project for the internet of things was presented during this project when creating solutions for the control of residence, providing practicality for the control of residential lighting, and have in hands, in the own cell phone an application that provides the control to control the residential lighting, with practicality to pre-program the system, so that when not detecting movements by the room that has a light or connected equipment, it is turned off after some time, generating more economy.

The lack of knowledge of the population regarding the use of Internet of Things with a new technology, provides a high cost charged by the workforce of an automated system, to be developed by professional companies, which are already acting in this field, this is a technology that people with knowledge on technologies have access these days, enabling new professional opportunities for students.

All knowledge and information acquired throughout this project can be used to build a lesson project that involves technology and sustainability, to mitigate the damages that have been caused to our planet, even if we use technology to our advantage. With this research, it can be observed that comfort and economy can be in the same place, besides having the interaction with the residence, there is still the option of having energy savings without leaving the place, and economy is a concept that is each more present in our day to day and, in addition, technology can contribute.

With the increased use of home automation, I observed many career opportunities, among others that involve controls for tax reductions among other bureaucracies, and even security, because many systems use the Internet, can be attacked by hackers and be used for negative things, or even to acquire information that can be used against the user himself. The expectation is that this technology is increasingly present in universities, schools, homes and businesses, providing more comfort to all and sustainability to our environment, which becomes a cheap technology and accessible to the entire population, who knows in a few years be as commonplace as a smartphone.

Due to its low cost and wide content available in the electronics market, this new technology provides a greater interest of the young, for the production of solutions that can facilitate the life of the people, being able to contribute to more complex projects and during classes that involve the interdisciplinarity, because they involve different lines of research, contributing, for example, to a computer class, or even a complete course in Computer Science, or Information Systems.


Acknowledgements

I would like to thank I Wayan Suryasa and María Rodríguez Gámez for their valuable time and advice to complete this paper.

References

1. Almeida, R. P. D. (2016). Gerenciamento de dados de proveniência de workflow de bioinformática com banco de dados baseados em grafo.
2. Banz, M., & Shiloh, M. (2015). Make-Getting started with Arduino: The open source electronics Prototyping platform, Make: Books.
3. Dubolia, R., Singh, R., Bhadoria, S. S., & Gupta, R. (2011, June). Digital image watermarking by using discrete wavelet transform and discrete cosine transform and comparison based on PSNR. In *Communication Systems and Network Technologies (CSNT), 2011 International Conference on* (pp. 593-596). IEEE.
4. Ramos, M. C., & Andrade, V. S. (2015). Desenvolvimento, construção e calibração de uma central de monitoramento de consumo de energia elétrica e de água utilizando o microcontrolador Arduino. *Anais do ENEDS*.
5. Brunini, D. D. M. (2017). Localização de descargas parciais em transformadores de potência por meio de sistemas inteligentes e emissão acústica.
6. Marconi, M. D. A., & Lakatos, E. M. (2010). Fundamentos de metodologia científica. 320p. *Atlas, São Paulo, SP, Brasil. ISBN, 978-8522457588*.
7. McRoberts, M. (2015). Arduino básico. *Novatec Editora, 2ªed*.
8. Monk, S. (2015). *Programação com Arduino II: Passos avançados com sketches*. Bookman Editora.
9. Schäfer, L. (2017). Desenvolvimento de um sistema de espectroscopia com matriz de detectores sensíveis à posição usando a plataforma Arduino.
10. Porter Jr, L. A., Washer, B. M., Hakim, M. H., & Dallinger, R. F. (2016). User-friendly 3D printed colorimeter models for student exploration of instrument design and performance.
11. Michels, L. B. (2017). Desenvolvimento de laboratório de experimentação remota didático para aprendizagem na área da conformação mecânica.
12. dos Santos, B. J., da Silva¹, C. C. J., Simbara, M., Rodrigues, P., Malmonge, S. M., & Leão¹, T. F. Automação do coletor rotativo no processo de produção de arcabouços via airbrushing para engenharia de tecidos.
13. Spivey, D. (2015). *Home automation for dummies*. John Wiley & Sons.
14. MS Leite Júnior, J. M., C Arêas, R., & C Sena, A. J. (2017). Automação Residencial: Monitoramento de Consumo de Energia Elétrica e Água. *INOVA TEC, 1*.
15. Tipan, E. D. M., Tombo, G. B. E., Castro, W. Q., Garcia, R. V. M., & Gámez, M. R. (2017). Reflections on the Implementation of Tidal Energy in Ecuador. *International Journal of Physical Sciences and Engineering (IJPSE), 1(3)*, 31-40.
16. Arauz, W. M. S., Cedeño, G. I., Chávez, S. S., Pérez, A. V., & Gámez, M. R. (2017). Microgrid With a 3.4 kWp Photovoltaic System in the Universidad Técnica de Manabí. *International Journal of Physical Sciences and Engineering (IJPSE), 1(2)*, 11-20.

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